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# Crowdsourcing HIV Test Promotion Videos: A Non-Inferiority Randomized Controlled Trial in China

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Weiming Tang<sup>1,2,3,\*</sup>, Ph.D., Larry Han<sup>1,2,4,\*</sup>, John Best<sup>1,2,6,\*</sup>, B.S., Ye Zhang<sup>1,2,3</sup>, M.S., Katie Mollan<sup>5</sup>, M.S., Julie Kim<sup>3</sup>, B.S., Fengying Liu<sup>2,3</sup>, M.D., Michael Hudgens<sup>4</sup>, Ph.D., Barry Bayus<sup>7</sup>, Ph.D., Fern Terris-Prestholt<sup>8</sup>, Ph.D., Sam Galler<sup>1,9</sup>, M.A., Ligang Yang<sup>2</sup>, M.D., Rosanna Peeling<sup>1,7</sup>, Ph.D., Paul Volberding<sup>5</sup>, M.D., Baoli Ma<sup>10</sup> B.S., Huifang Xu<sup>11</sup>, M.D., Bin Yang<sup>2,3</sup>, Ph.D., Shujie Huang<sup>2,3</sup>, M.D., Kevin Fenton<sup>12</sup>, Ph.D., Chongyi Wei<sup>6</sup>, Dr.PH., Joseph D. Tucker<sup>1,2,3</sup>, M.D.

1 University of North Carolina Project-China, No. 2 Lujing Road, Guangzhou, China, 510095;

2 Guangdong Provincial Centres for Skin Diseases and STI Control, No. 2 Lujing Road, Guangzhou, China, 510095;

3 SESH Global, No. 2 Lujing Road, Guangzhou, China, 510095;

4 Department of Biostatistics, University of North Carolina at Chapel Hill, 170 Rosenau Hall, 135 Dauer Drive, Chapel Hill, NC, USA 27599

5 School of Medicine, University of North Carolina at Chapel Hill, 170 Rosenau Hall, 135 Dauer Drive, Chapel Hill, NC, USA 27599

6 School of Medicine, University of California, San Francisco, 550 16th Street San Francisco CA, USA 94158

7 Business School, University of North Carolina at Chapel Hill, CB 3490 Chapel Hill, NC 27599;

8 Department of Global Health and Development, London School of Hygiene & Tropical Medicine, 202, LSHTM, 15-17 Tavistock Place, London, UK, WC1E 7HT;

9 University of Oxford, Oxford, UK, OX2 6HD;

10 Danlan, Beijing, China, 100000;

11 Department of HIV/AIDS prevention and control, Guangzhou Center for Disease Control and Prevention, No.2 Jiangheqide Road, Baiyun, Guangzhou, China, 510440.

12 Public Health England, Wellington House, 133-155 Waterloo Road, London, UK, SE1 8UG

\*Weiming Tang, Larry Han, and John Best contributed equally to this research.

## **Correspondence:**

Joseph D. Tucker

University of North Carolina Chapel Hill Project-China

No. 2 Lujing Road, Guangzhou, China, 510095

E-mail: jdtucker@med.unc.edu

**Summary:** We conducted a RCT to evaluate a crowdsourcing approach to promote HIV testing in China. The crowdsourcing approach is a participatory open contest soliciting short videos encouraging HIV testing followed by implementation of the best crowd-generated video as an intervention.

## **Abstract**

**Background** Crowdsourcing, the process of shifting individual tasks to a large group, may enhance HIV testing interventions. We conducted a non-inferiority, randomized controlled trial (RCT) to compare first-time HIV testing rates among men who have sex with men (MSM) and transgender individuals who received a crowdsourced or a health marketing HIV test promotion video.

**Methods** MSM and transgender participants (N = 721,  $\geq 16$  years old, never before tested for HIV) were recruited through three Chinese MSM web portals and randomly assigned to one of two videos. The crowdsourced video was developed using an open contest and formal transparent judging while the evidence-based health marketing video was designed by experts. Study objectives were to measure HIV test uptake within four weeks of watching either HIV test promotion video and cost per new HIV test and diagnosis.

**Results** Overall, 624/721 (87%) participants from 31 provinces in 217 Chinese cities completed the study. HIV test uptake was similar between the crowdsourced arm (37%, 114/307) and the health marketing arm (35%, 111/317). The estimated difference between the interventions was 2.1% (95% confidence interval, -5.4% to 9.7%). Among those tested, 31% (69/225) reported a new HIV diagnosis. The crowdsourced intervention cost substantially less than the health marketing intervention per first-time HIV test (131 USD/person vs. 238 USD/person) and per new HIV diagnosis (415 USD/person vs. 799 USD/person).

**Conclusions** Our nationwide study demonstrates that crowdsourcing may be an effective tool for improving HIV testing messaging campaigns and could increase community engagement in health campaigns.

## **Introduction**

At a 1906 county fair in England, a group of individuals was asked to guess the weight of an ox. The median estimate of the crowd was accurate to within 1% of the actual weight and better than any estimate from agricultural experts. This shows the wisdom of crowds or communities in specific contexts.(1) Crowdsourcing is the process of shifting individual tasks to a large group. It often involves open contests and is enabled through multisectoral partnerships.(2, 3) Crowdsourcing has been used extensively in the private sector(2) and has been championed by the National Institutes of Health in the United States as an effective tool to solicit new ideas in health research.(4)

Crowdsourcing may overcome three common problems encountered in designing and implementing new HIV testing interventions. First, when designing interventions, researchers tend to gravitate towards ideas that resemble previous work, resulting in less creative ideas.(5, 6) Second, when community-based HIV testing interventions are implemented, the input of key affected populations is often relatively limited.(7, 8) Third, aside from HIV testing programs arising from community based participatory research(9), many HIV testing campaigns result from a top-down, expert-driven process.(10) In contrast, crowdsourcing draws on the collective knowledge of the community instead of experts, empowering communities to develop novel and creative solutions.

The World Health Organization has recognized community engagement as a key social enabler for scaling up HIV testing services and eliminating new HIV infections,(8) and HIV community engagement has been associated with increased HIV test uptake,(11) effective task-shifting(12) and expansion of HIV treatment services.(12-14) Community engagement is increasingly important as key populations bear a greater burden of the HIV epidemic, now

accounting for more than half of all new HIV infections in many countries.(8)

Crowdsourcing could be a powerful tool to enhance HIV testing campaigns by harnessing the power of community engagement to generate creative, new ideas to promote HIV testing.

Our research group organized a creative contributory contest(15) to solicit videos promoting HIV testing. The contest included an open call to the public, transparent judging, and showcased top videos. To compare the effectiveness of a crowdsourced intervention versus a health marketing intervention to promote first-time HIV testing among men who have sex with men (MSM) and transgender individuals in China, we conducted a non-inferiority pragmatic randomized controlled trial.

## **Methods**

### **Intervention development**

The crowdsourced intervention has been described in detail elsewhere.(15) Development of the intervention for this trial included the following steps. First, we posted a public call for videos promoting HIV testing and hosted a call to increase awareness of the contest. Second, a group of multisectoral judges, including researchers, community health leaders, public health and marketing experts, and business leaders, evaluated each of the video entries with a score of 1 to 10 (1 = worst, 10 = best). The judges identified a single contest winner based on the capacity to reach untested individuals, generating excitement, and community responsiveness. Finally, the winning video was included in the intervention arm of this trial (Supplement A, Crowdsourcing Video). The one minute video showed two Chinese men falling in love and getting HIV tested together. The health marketing video intervention was developed independently from the contest by a small marketing company with the guidance of a municipal public health bureau (Supplement B, Health Marketing Video). The one

minute health marketing video included a cartoon providing HIV education and promoting HIV testing.

### **Study design and participants**

We chose a non-inferiority design without a control group for two reasons. First, there is already substantial evidence demonstrating the effect of brief marketing interventions on HIV testing described in two Cochrane systematic reviews.(10, 16) Second, given the need to expand HIV testing among MSM in China(17), there would be ethical concerns associated with withholding an evidence-based intervention from untested MSM.(18)

We recruited participants from Chinese MSM web portals.(19) An MSM web portal is an online entry point for social networking, finding sex partners, exchanging news, and banner advertising. We selected one MSM web portal, respectively, in the northern, southern, and eastern regions of China. These three portals collectively have an estimated 90,000 unique users each day. We piloted an online survey to evaluate the effectiveness of the crowdsourced versus the health marketing video among 150 MSM and transgender individuals. Extensive formative work, including interviews with MSM and input from survey design experts and anthropologists, informed the development of the online survey tool (Qualtrics).(20) We followed standard guidelines for reporting online surveys and randomized controlled trials (Supplement C, CHERRIES and CONSORT Checklists).(21-23)

Participants were recruited through a banner link on the MSM web portal home pages and an announcement about the study was sent to registered users of the portals. Participants who clicked on the link were directed to eligibility screening and consent.(19) Inclusion criteria were being born biologically male, had anal sex with a man at least once, at least 16 years of

age, never tested for HIV, and able to provide a cell phone number for follow up.

Biologically born men who currently identified as female or transgender were included.

Participants who entered the same telephone number more than once to join the survey were excluded.

### **Randomization and follow-up**

After individuals were screened for eligibility, enrolled, and completed the survey, each study participant was randomly assigned to either watch the crowdsourced video or the health marketing video.(24) Participants, web portal administrators, and researchers were all masked to group assignment. A text message was sent to participants three weeks after survey completion asking about HIV test uptake and test result. An identical second follow-up text message was sent to non-responders in the fourth week.

### **Measures**

The primary outcome of this study was self-reported first-time HIV testing. We pre-specified a self-reported HIV testing outcome because HIV testing in China is largely anonymous(25), HIV self-testing is common(26), and using facility-based capture of testing outcomes would fail to reach the substantial portion of MSM in China who do not seek facility-based services. Secondary outcomes were cost per first-time HIV test and per new HIV diagnosis and change in likelihood of HIV testing (Likert scale rating).

Socio-demographic characteristics collected in the baseline questionnaire included age, education, income, marital status, and sexual orientation disclosure. Participants were asked whether they had engaged in anal intercourse in the last six months, and if so, whether they had used a condom during their most recent instance of anal sex. Participants were also asked

if they had ever used a gay mobile application to find a sex partner. We collected data on likelihood of HIV testing before and after the participants watched the respective videos (very unlikely, unlikely, likely and very likely).

We collected cost data for all expenditures from organizations that submitted entries to the crowdsourcing contest – the organization that organized the crowdsourcing contest, Social Entrepreneurship for Sexual Health (SESH Global), the local public health bureau that guided the development of the health marketing video (Chinese Centres for Disease Control), and the three web portals that provided participant recruitment platforms for our study. Costs included all resources in addition to those resources donated by community-based organizations for all submitted videos, equipment and facilities for both arms (crowdsourced video and health marketing video), and volunteer personnel costs, including judging. Data collected also included costs for the above organizations to coordinate, generate, evaluate and disseminate videos.

### **Statistical analysis**

We examined the hypothesis that the crowdsourced video was not inferior to the health marketing video to promote HIV testing. The primary endpoint was difference in proportions having self-reported HIV testing, with a non-inferiority margin of -3%. The lower limit of a Wald 2-sided 95% CI was used to evaluate non-inferiority. Effect modification was assessed using a linear probability model(27) based on three pre-specified subgroups: video watching (first-time versus multi-time), web portal viewed (northern web portal compared to the other two web portals), and risk behavior (recent condomless anal sex, defined by use of condom during last anal sex), all measured at baseline.

Demographics and sexual behaviours were compared between participants who replied to the post-survey text message and those who did not. According to the pre-specified statistical analysis plan, the primary analysis included individuals who replied to a text message, i.e., a complete case analysis. As a sensitivity analysis, multiple imputation was used to impute the missing responses at follow-up. Predictors in the imputation model were age, highest education, province from which the individual accessed the study, study arm, prior exposure to the intervention video (crowdsourced or health marketing), and the web portal through which an individual accessed the study.

In addition, in order to test the effectiveness of crowdsourcing versus health marketing video on the change in the likelihood of HIV testing by participants, a Cochran Armitage trend test was conducted. All individuals were asked how likely they were to test for HIV immediately before and after watching the video. Likelihood of HIV testing was measured on a 4-point numerical Likert scale ("very unlikely", "somewhat unlikely", "somewhat likely", and "very likely"). For all comparisons, a 2-sided p value of less than 0.05 was considered a statistically significant difference. Statistical analyses were conducted in SAS version 10.3 (SAS Inst. Cary, NC, USA).

For cost data collected, we estimated the total and incremental unit costs of introducing a crowdsourced and a health marketing video to promote HIV testing per first-time HIV tester and per new HIV diagnosis.<sup>(28)</sup> We first calculated the total cost for each arm (crowdsourced video and health marketing video), then divided these costs by the number of participants newly tested and the number of newly identified HIV cases in each arm to obtain the incremental unit costs. In addition, the ratios and cost saving between the two arms were calculated using the health marketing group as the reference group.

## **Ethical Statement**

The study protocol was approved by Chinese (Guangdong Provincial Centre for Skin Diseases and STI Control) and American (University of North Carolina at Chapel Hill and the University of California, San Francisco) institutional review boards (Supplement D, Study Protocol). The study was registered with ClinicalTrials.gov(19), number NCT02248558, prior to trial enrolment. A Data Monitoring Safety Board was not established because there were minimal risks associated with the intervention.

## **Results**

### **Study participants**

Overall, the study link was clicked 5,339 times. Of these, 1,536 withdrew from the survey prior to reading the consent form and 656 were excluded for not signing the consent form. Among the remaining 3,147 clicks, 1,328 did not meet eligibility requirements and 395 duplicates were excluded (by checking recorded phone numbers). A total of 1,424 persons completed the online survey, including 721 (51%) participants who had never tested for HIV. Of these 721 individuals, 352 were randomly assigned to the crowdsourced intervention and 369 to the health marketing intervention (Figure 1).

Participants accessed the video evaluation survey from 31 provinces in 217 cities (Supplement E, Distribution of Participants). A majority of participants were between 16 and 25 years old (69%), had disclosed their sexual orientation (57%), had a college degree or higher (70%), were never married (85%), and used gay mobile applications to find sex partners (76%). Almost all participants (95%) identified as men and the rest identified as women or transgender. Nearly a third of participants (31%) who had sex in the previous six

months reported condomless anal sex with their most recent partner. Demographics and behaviours were similar between the two randomly assigned study arms (Table 1).

### **Primary HIV testing outcome**

Of the 721 participants, 624 (87%) replied to the text message. Response rates were similar between the two study arms [crowdsourcing, 87% (307/352); health marketing, 86% (317/369)]. Of the 624 total respondents, 225 (36%) reported having tested for HIV within four weeks after watching their assigned HIV test promotion video. In the crowdsourced intervention arm, 114 of 307 (37%) reported testing for HIV compared to 111 of 317 (35%) in the health marketing arm. For the complete-case analysis, the estimated difference in proportions between arms was 2.1% (95% confidence interval (CI): -5.4%, 9.7%). Using multiple imputation, the estimated difference in proportions was 3.1% (95% CI: -4.5%, 10.7%) (Table 2). In both analyses, the CI included values below the pre-specified non-inferiority margin of -3%, thus non-inferiority was not demonstrated. Of those who tested for HIV, 30.6% reported a positive test.

We assessed the differences in proportions tested between the crowdsourced and health marketing arms using effect modification (Table 3). There was no significant effect modification between interventions for video watching frequency ( $p=0.30$ ), web portal ( $p=0.20$ ) and recent condomless sex behaviour ( $p=0.77$ ) (Table 3). Participants who saw their assigned video more than once were more likely to report HIV test uptake compared to participants who saw the video only once. For example, those who watched the crowdsourced video more than once were more likely to test for HIV compared to those who watched the crowdsourced video only once, with a risk difference of 25.8% (95% CI 15.0, 36.7)

(Associations between baseline covariates and multi-time video watching are presented in Supplement F).

### **Secondary outcomes**

A Cochran-Armitage trend test for the change in likelihood of HIV testing before and following the respective videos did not detect a significant difference between the two interventions.

Table 4 shows the results of the costing analysis, including total and incremental unit cost per person tested and HIV-infected person identified in each group, the ratio between the two groups, and the cost saved by the crowdsourced method.

The total cost for the crowdsourced group was \$14,926 (United States dollars (USD)), which was lower than the health marketing group (\$26,358 USD), with a cost savings of \$11,432 USD. The incremental unit cost for promoting HIV testing among MSM and transgender individuals in China was \$131 USD in the crowdsourced group and \$238 USD in the health marketing group (45% reduction) (Table 4). The incremental unit costs per newly diagnosed HIV infection in the crowdsourced group and health marketing group were \$415 USD and \$799 USD, respectively (48% reduction).

### **Discussion**

Our nationwide study spanned 31 provinces and 217 cities in China, identifying MSM with sociodemographic and risk behaviours similar to that of a nationwide survey of over 40,000 MSM.<sup>(17)</sup> We found that a crowdsourced HIV testing campaign, despite not meeting the

non-inferiority hypothesis, was largely successful in promoting first-time HIV testing among MSM and transgender individuals compared to a health marketing campaign. Promoting HIV testing among key populations is a major global health priority.(29) However, most campaigns focused on improving HIV testing among key populations have shown limited capacity to reach hidden populations(30) and have limited community engagement.(10, 29) Our data extend previous research promoting HIV testing among key populations by using a randomized study design, measuring first-time testing, calculating cost, and expediting recruitment using online MSM portals. One of the three web portals recruited 1,100 participants in only 72 hours. Our study expands the limited literature on crowdsourcing(31) and is the first randomized clinical trial evaluating crowdsourcing methods to improve a health outcome. Our study suggests that crowdsourcing generates innovative health messages and may increase community engagement.(32)

Our study was able to effectively reach a large number of high-risk MSM who had never received an HIV test before and never told their doctor about their sexual orientation. While several previous HIV testing interventions have effectively reached men already engaged in health systems,(33) few interventions have focused on or been able to reach the subset of MSM who do not disclose their sexuality. In our sample, almost half of the men (43%) had never disclosed their sexual orientation to anyone (except sex partners), such as a physician or health professional. This highlights the power of the Internet as a tool for reaching subsets of key populations who may not disclose their sexual orientation or seek formal facility-based services. The observation that the Internet may be a useful tool for recruiting high-risk, closeted MSM is consistent with research from Peru(34) and the US.(35)

Our results also suggest that crowdsourcing may be a cost saving tool for increasing key population engagement in HIV services provision. In our study, the cost of a crowdsourced intervention was approximately half that of the cost of a health marketing intervention (\$14,926 versus \$26,358 USD). The cost to identify new HIV cases in our study was higher than the cost described in South Africa(36), but lower than costing studies in the US(37) and Spain.(38) However, our study did not quantify the organizational capacity-building accrued to the community based organizations who submitted videos, data that might be useful in structuring HIV testing programs in the future. As international HIV funding decreases around the world, community-based organizations are increasingly resource-constrained and may benefit from the additional capacity building resulting from crowdsourcing to enhance service delivery.

Our study has several limitations. First, both video interventions were brief and relatively simple. Yet other research suggests that the effect of such videos on testing would be observable soon after viewing.(16) We anticipate that such a media intervention would be one component of a comprehensive HIV intervention package. Second, we did not collect testing or biological data to verify text message self-reports. Nevertheless, previous studies have demonstrated text messages to reliably correlate with health outcomes and sexual behaviours.(39, 40) Third, 13% of participants did not respond to our text message and this could introduce bias. However, the responders and non-responders were similar in socio-demographics and risk behaviours, and the imputation results accounting for non-response closely matched the complete case data. Finally, the pre-specified non-inferiority criteria was not met because self-reported testing rates in both groups were much higher than anticipated resulting in a wider than planned confidence interval for the difference in proportions HIV tested

Our results suggest the potential for crowdsourcing to spur creative, new ideas for improving health and engaging communities. Our initial findings and research methods should be further expanded with larger and more powerful studies in the future. In addition, future qualitative studies should further investigate factors influencing our results to aid in adaptation of these approaches to new situations. This new tool may be especially useful in low and middle-income countries where civil society organizations are often constrained or less able to directly inform public health programs. Crowdsourcing contests may help create more engaging, effective, and creative campaigns.

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## Tables

**Table 1. Baseline characteristics of study participants recruited into the RCT in China, 2014 (n=721).\***

Characteristic	Crowdsourced (N=352)	Health Marketing (N=369)
<b>Gender – no. (%)</b>		
Male	334 (95)	351 (95)
Transgender†	18 (5)	18 (5)
<b>Age – yr – no. (%)</b>		
16 – 20	120 (34)	114 (31)
21 – 25	136 (39)	130 (35)
26 – 30	50 (14)	62 (17)
31 – 35	28 (8)	36 (10)
> 35	18 (5)	27 (7)
<b>Highest Education – no. (%)</b>		
High school or below	108 (31)	105 (29)
College	231 (66)	239 (65)
Graduate education	13 (4)	25 (7)
<b>Annual Income – USD (%)</b>		
< 3,000	113 (32)	128 (35)
3,000 – 6,000	104 (30)	102 (28)
6,001 – 9,500	84 (24)	85 (23)
9,501 – 15,000	37 (11)	38 (10)
> 15,000	14 (4)	16 (4)
<b>Marital Status – no. (%)</b>		
Never married	311 (88)	304 (82)
Married / engaged	31 (9)	50 (14)
Separated / divorced / widowed	10 (3)	15 (4)
<b>Disclosure of sexual orientation – no. (%)‡</b>		
Disclosed to others	199 (56)	210 (57)
Not disclosed to others	153 (44)	159 (43)
<b>Ever used gay mobile application – no. (%)§</b>		
Yes	275 (79)	267 (73)
No	71 (21)	97 (27)
<b>Recent condomless anal sex – no. (%)¶,</b>		
No recent sex	47(15)	58(18)
Condomless anal sex	86 (28)	74 (23)
Anal sex with a condom	174 (57)	185 (58)

\* The baseline characteristics are shown for individuals who had never tested for HIV and were thus eligible for the randomized video intervention; † Born biologically male and now identify as female or transgender; ‡ Has told anyone besides sexual partner about their sexual orientation or sexual behaviors;¶ Only for those who reported condomless anal sex with most recent partner in previous 3 months; § 11 participants were missing data for ever used gay mobile application

**Table 2. Non-inferiority analysis of RCT in China, 2014 (n = 721).\***

<b>Video</b>	<b>Tested – No. (%)</b>	<b>Difference in proportions (%)</b>	<b>95% CI (%)</b>
<b>Complete-record analysis (n = 624)</b>			
Crowdsourced	114/307 (37.1)	2.1	(-5.4, 9.7)
Health marketing	111/317 (35.0)		
<b>Multiple imputation analysis (n = 721) †</b>			
Crowdsourced	132/352 (37.5)	3.1	(-4.5, 10.7)
Health marketing	127/369 (34.4)		

\* Non-inferiority analysis assessed the difference in proportions of HIV testing between crowdsourced and health marketing interventions.

† Ten imputations were conducted to attain the average tested number and percentage.

**Table 3. Sub-analyses of crowdsourced and health marketing interventions in RCT in China, 2014.**

Subgroup	Crowdsourced <i>Tested/Total (%)</i>	Health Marketing <i>Tested/Total (%)</i>	Difference in proportions (95% CI, %)	P value for interaction‡
<b>Video Watching</b>				
Multi-time	66/126 (52)	67/151 (44)	8 (-4, 20)	0.30
First time	48/181 (27)	44/166 (27)	0 (-27, 27)	-
<b>Web Portal</b>				
Northern portal	106/280 (38)	90/266 (34)	4 (-4, 12)	0.20
Other portals†	8/27 (30)	21/51 (41)	-11 (-32,11)	--
<b>Condomless Sex¶</b>				
No recent sex	36/83 (43)	33/94 (35)	8 (-6,22)	0.77
Condomless anal sex	28/71 (39)	26/62 (42)	-3 (-19,14)	--
Anal sex with a condom	50/153 (33)	52/161 (32)	1 (-10, 11)	--
† Southern and eastern portals combined; ‡ Wald test; ¶ Reported condomless anal sex with most recent partner in last six months, n=624.				

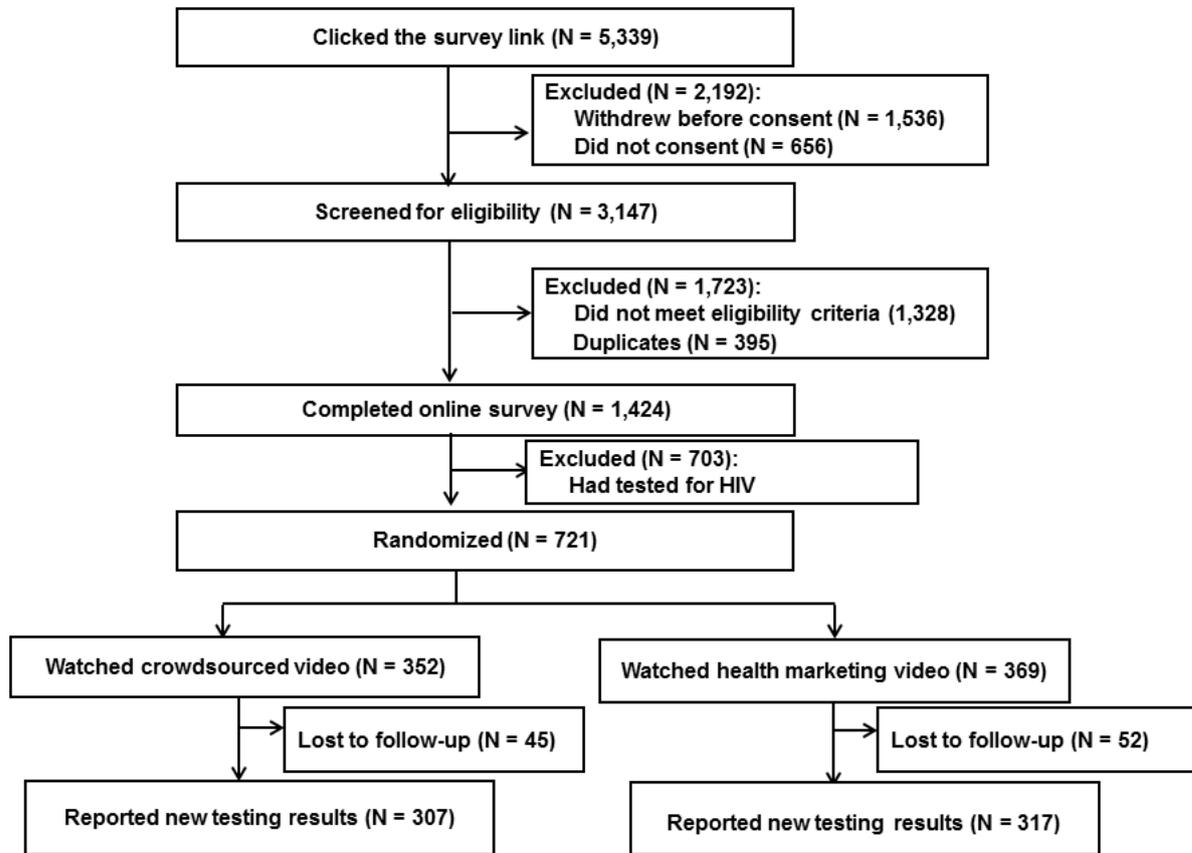
**Table 4. Costing data associated with the two interventions in China, 2014.\***

	Crowdsourced (N = 352)	Health marketing (N = 369)	Cost savings†	Ratio
Total Cost (USD)	14,926	26,358	11,432	0.56
Follow-up results				NA
No. testers	114	111	NA	
No. HIV positive cases	36	33	NA	NA
Cost per person tested (USD)	131	238	107	0.55
Cost per new HIV positive case identified (USD)	415	799	384	0.52

\* Costing data per person tested and per HIV-positive individual identified by using crowdsourced and health marketing interventions among MSM and transgender individuals; † Cost savings was calculated as cost in health marketing arm – cost in crowdsourcing arm; ‡ Ratio is defined as the cost of the crowdsourced arm relative to the health marketing arm.

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**Figure 1. Study cohort.**



**Figure 1 Study Cohort**

\*Duplicates assessed by mobile phone number.

## **Supplementary Data Legend**

**Supplement A. Crowdsourcing Video**

**Supplement B. Health Marketing Video**

**Supplement C. CHERRIES Checklist and CONSORT Checklist**

**Supplement D. Study Protocol**

**Supplement E. Distribution of Participants in China**

**Supplement F. Correlates of Multi-time Testing Video Watching among Chinese MSM,  
2014 (n =721)**

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